Structure of Atomic Nuclei. L. Satpathay (ed.), Narosa Publishing House, 6 Community Centre, Panchsheel Park, New Delhi 110 017. 1999. 356 pp. Price not stated.

The atomic nucleus is a fascinating many-body system involving strongly interacting particles. As the building blocks of a nucleus, protons and neutrons are themselves composites of quarks and gluons, it is the dream of the theorists to describe the nuclei starting from the quantum chromodynamics (QCD) – the fundamental theory of strong interaction. However, it is premature at this stage to think of the behaviour of a heavy nucleus directly in terms of the underlying quark–gluon dynamics. Therefore, the nuclei are studied by simplifying the problem in which the subnucleonic structures are replaced by nucleons interacting through effective forces. Even then, it is extremely difficult to describe all aspects of the nuclei as seen by the experimentalists. The number of nucleons in the nuclei is too large to allow an exact treatment, yet they are too few to become amenable to theories used to describe the infinite systems. This implies that the concepts and techniques used successfully to investigate the many-body systems like solids and molecules cannot be applied here.

The book *Structure of Atomic Nuclei*, contains a written version of the talks presented by practitioners of this field in our country in a SERC school in Nuclear Structure Physics, held in Puri during 18 November–7 December 1996. The book deals with almost all the techniques and methodologies that are used currently to study the structure of nuclei. It ranges from effective interactions to collective models to more microscopic many-body methods.

The common theme for the whole field of nuclear structure is the problem of determining the force (effective interaction) that acts between two colliding nucleons in the presence of other nucleons. This interaction which leads to exotic structures (like the 'halo' formation) in the light nuclei and gives rise to collective motion in heavy nuclei, has to be derived from the underlying quark–gluon dynamics of QCD. Experimentally, the nucleon–nucleon (*NN*) interaction can be determined by parameterizing a large body of the data on *NN* scattering experiments. Latest examples of such parameterizations are Bonn, Paris, Nijmegen, and Argonne potentials. Starting from this free *NN* interaction one has to obtain the 'effective' *NN* force. This topic is discussed in the first chapter of this book. In principle, such a force has to be obtained by means of a complicated Brückner renormalization procedure which corrects the free *NN* interaction for the effects arising due to presence of other nucleons. The techniques of the solution of the many-body Hamiltonian starting from a free *NN* interaction (Bethe–Goldstone and Bethe–Brückner theories) are dealt with extensively in this chapter. However, a description of the developments that have taken place in this area recently (see e.g. the review[1]) would have made these discussions more useful and up-to-date.

The basic conceptual framework to describe the structure of nuclei is still that of the nuclear shell model, where the basic assumption is that nucleons are moving almost independently in a mean potential generated from the effective *NN* interaction. However, the shell model calculations utilizing this concept in a restricted configuration space have been limited to medium mass nuclei owing to the rapid growth of the size of the model space. Although the state-of-the-art shell model studies of the $A = 47$ and $A = 49$ *fp* nuclei in a full space have been made, further progress in this field is strongly limited by the available computer resources. Hence traditional shell model calculations of heavy nuclei appear out of reach in the near future even with the startling rate at which the computing power is growing. The recently developed shell-model Monte Carlo method (SMMC)[2], which uses path integral techniques, allows realistic calculations in model spaces otherwise intractable. This approach has been remarkably successful in describing many structural properties of heavy nuclei like ^{64}Ge or ^{124}Xe. Less ambitious methods developed mostly during late sixties and early seventies, employ various approximate schemes which facilitate calculations for the heavy nuclei while still keeping the spirit of the shell model intact. Chapter 6 of the book provides a good discussion of these approaches.

The low-energy properties of the nuclei near the magic ones are primarily decided by the behaviour of a few valence nucleons. However, for nuclei away from this region (which have many valence particles), the valence and inner shell nucleons have to be treated on an equal footing. Many properties of these systems are well described by self-consistent theories with density-dependent *NN* interaction. For these cases, the static mean field description, based on the Hartree–Fock (HF), Hartree–Fock–Bogolyubov (HFB) methods or relativistic mean field (RMF) theories provides a useful starting point. These approaches (except for RMF) are discussed in chapters 4, 5, and 7. Due to the advances made in the computational techniques, large-scale self-consistent mean-field calculations (employing microscopic effective interactions) are now widely used to study the properties of the heavy nuclei. These calculations have reached to a stage where their *predictive power* is almost at par with that of the more phenomenological macroscopic–microscopic methods discussed in chapter 3.

The use of group theoretical methods in the description of the structure of nuclei was given a firm footing in 1975 by Arima and Iachello[3], who introduced the interacting Boson model (IBM). Depending upon the need to include various degrees of freedom, a number of versions of this model (e.g. IBM-2, IBM-3, IBM-4, sdgIBM, etc.) have been put forward. Chapter 8 presents a comprehensive up-to-date treatment of all these versions and their applications in the description of the experimental data. A comment, however, is in order here. Where does the construction of various versions of this model stop! This article does not provide an answer to this. From the discussions presented in this chapter one gets the feeling that there is some sort of an underlying freedom of constructing one for every situation.

There are a couple of chapters at the end of this book which provide a good overview of the experimental techniques of nuclear spectroscopy. Theoreticians sometime tend to overlook this aspect. These chapters which are done rather well, supplement in some way the theoretical discussions presented in earlier part of the book.

The technological developments in the production and acceleration of the radioactive nuclear beams (RNB) have taken the frontiers of the nuclear structure physics to the extremes of (i) neutron number to proton number ratios (N/Z), (ii) atomic charge and nuclear masses, and (iii) angular momentum. New data emerging from these studies are expected to provide new information about the effective NN interaction, properties of the pairing force, properties of the pure neutron matter at very low densities, nuclear shell structure, neutron–proton pairing, etc. It may also be possible to synthesize the long predicted super heavy elements (SHEs) in the laboratory. The discovery of SHEs will not only test the nuclear structure models but also the predictions of the relativistic quantum chemistry, according to which the velocity of the inner-shell electrons will approach that of light for nuclei with atomic number in the vicinity of 137. This is expected to cause deviations from the periodicity of the chemical properties which is the hallmark of the periodic table for lighter elements. The properties of new exotic nuclei are also of great interest in the field of nuclear astrophysics, as such nuclei are produced in many astrophysical sites. Therefore, we are in an exciting era in the field of nuclear structure physics.

Unfortunately, one misses even a glimpse of it in this book. Perhaps the mandate and level of the school could have been one reason for this. This probably also is the reason for some authors relying too heavily on the material available in standard textbooks[4] for the preparation of their articles. Even then the utility of the book could have been enhanced greatly, if the problems solved together with the lectures were also included (this has been done in chapter 6 only). There are several technical faults in this book, e.g. there are numerous typographical errors, figures in some of the articles are too blurred and captions are illegible, different styles have been used by different authors in the preparation of their articles which diminishes the cohesiveness of the book.

Nevertheless, this book should be useful for students just starting their research work in nuclear structure physics, as it provides a good guide to various techniques used in these studies at one place.

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1. Hjorth-Jensen, M., Kuo, T. T. S. and Osnes, E., *Phys. Rep.*, 1995, **261**, 125.
2. Koonin, S. E., Dean, D. J. and Langanke, K., *Phys. Rep.*, 1997, **278**, 1.
3. Arima, A. and Iachello, F., *Phys. Rev. Lett.*, 1975, **35**,1069; 1978, **40**, 385.
4. Pal, M. K., *Theory of Nuclear Structure*, Affiliated East-West Press, New Delhi, 1982.

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Genetics and the Extinction of Species. Laura F. Landweber and Andrew P. Dobson (eds). Princeton University Press, 41 William Street, Princeton, New Jersey 08540, USA. 1999. 189 pp. Price: US$ 19.95/£ 12.50 (paper).

Conservation today is a buzzword whose echoes are heard in areas far removed from population biology. Newspapers and magazines carry articles on conservation and biodiversity, some people agitate for conservation while others get agitated by such agitations. Even politicians talk about conservation. This is all to the good, for conservation is an issue with biological, sociological, economic and, therefore, political dimensions, and practicable solutions to problems in conservation biology cannot be found by biologists alone. Yet, there is a flip-side to all of this hype about conservation. Biological inputs into seeking solutions of conservation problems are frequently pushed into the background, while vociferous arguments about human rights and 'mother earth' rhetoric occupy centre stage (Have you ever seen a newspaper article that tried, for example, to educate its readership about random genetic drift or metapopulation dynamics?). Even more unfortunate is the fact that the arguments for conservation are all too often being made by people who combine an impressive passion for conservation, and rhetoric, with an almost equally impressive lack of knowledge of population biology. And even among biological disciplines important to conservation, genetics has gradually been losing visibility, even though it is central to many issues in conservation.

Genetics and the Extinction of Species, an edited volume of eight papers presented at a symposium held at Princeton University in 1996, goes some way toward redressing the marginalization of genetics in conservation issues. As is inevitable in compilations of this kind, several important areas at the intersection of genetics and conservation are not represented. Notably lacking are discussions of genetic techniques for reconstructing the past geographic range of species, the effects of reduced genetic variation on disease susceptibility, and the impact of modern genetic technology on systematics. Yet, the book is, overall, a good and concise compilation of information on many aspects of genetics and demography, and their implications for conservation.

The first chapter by Russell Lande provides a brief summary of what is known about the impact of various anthropogenic, ecological and genetic factors on the probability of a population going extinct. This is a clearly written chapter, although some sections may be difficult to grasp for a reader unacquainted with population ecology and population genetics. Nevertheless, there are some useful messages here for people who are involved in devising conservation strategies. Lande makes the point that it is often initially due to human activities such as agriculture, forest and fishery exploitation, pollution, and introduction of exotic species, that species are pushed towards lower population numbers. Reduced numbers, in turn, lead to a spiral of ecological and genetic effects, such as altering the equilibrium number of occupied patches in a metapopulation or inbreeding depression. Therefore, it is better to focus on identifying and redressing anthropogenic activities that cause initial decline in abundance, rather than to concentrate on the ecological and genetic syndromes associated with low population numbers, because by that time, it would be almost too late. Lande also points out how the standard economic practice of discounting future profits (often by more than 10%) results in overexploitation, often to the verge of extinction of, species with low annual per capita rates of increase (i.e. species with large generation times and/or low fecundity).